CONCEPTS & MISCONCEPTIONS CONCERNING THE USE AND ABUSE OF CPM FOR CONSTRUCTION

By Herbert M. Priluck*

(Presented at a meeting of The Construction Section, B.S.C.E., March 24, 1965.)

I. Introduction

Those who expect to find some magic formula in Critical Path Method (CPM) to cure all the ills and pains of constructing a project will be surely disappointed.

CPM, at times, is being used as an advertising gimmick to indicate that whatever is in any way associated with it must, by association, be modern and possessing some mystical power. It recently was amusing to see in a widely read engineering magazine an advertisement proclaiming that X Brand patent forms kept Contractor A on the critical path, followed a few pages later by an advertisement stating that Y Brand power shovel keeps Contractor B off the critical path.

In order to gain an entree into the construction industry, some proponents of CPM have made grandiose claims about the wonders of CPM. Many usually circumspect contractors, architect/engineer firms and owners have been overawed by terms such as complete project control, parametric linear programming, electronic digital computer, management by exception, etc. Were these claims made about any other management tool, such as cost control, or time study, they would surely be received with ridicule rather than awe.

Physically, CPM is an inert series of lines, circles, words and numbers on paper. Any statement that CPM does, can do, or will do some miraculous task must be written off or at least taken with a grain of salt.

In truth, in the hands of a competent construction manager, CPM is a powerful tool which when skillfully applied can yield results not readily obtainable with less sophisticated projected management tools.

It is a new tool developed by the construction department of

* President, Construction Planning Management Inc., 79 Stearns Road, Brookline, Massachusetts.

Dupont in the late 1950's to insure completion of their in-plant process change-over projects with a minimum of lost production time. The significant feature of CPM, which sets it apart as new, is the separation of planning from scheduling, and the treatment of each in a systematic manner. Thus, the necessity of juggling in one's mind the various parts of the work, their interrelation, the time it takes to do each job making up the project, and its effect on and place in the overall time-scale of the project, is eliminated.

II. Basic Concepts

It is necessary to outline the basic concepts of CPM as applied to construction.

Project planning scheduling and *control* is the function of CPM in construction.

CPM is a *project* management tool. It does not apply to a continuous flow process. A project must be defined as a group of interrelated activities making up a specific overall task which has a distinct start and a distinct finish. For example, CPM can be used to construct a bakery but is not useful in managing the production of cookies ad infinitum. It can be used to manage the formulation (or if need be the dissolution) of a business enterprise but not the on-going functions of the firm.

Planning, in the context of CPM, is the study of the activities comprising a project and their interrelationship, presented in a systematic manner. In the planning stage, a uniform set of symbols are used according to specific rules to represent graphically the plan of action for the project. This graphic representation is the CPM chart or arrow diagram. We are accustomed to such a graphic representation of *what* we will build in the form of architectual, structural and many other drawings. A CPM network is similarly a graphic representation of *how* we will build.

Scheduling, is the second phase of CPM application. A reasonable estimate must be made of the time required to perform each of the activities shown on the CPM chart developed in the planning stage. At this point the "method" aspect of CPM is most evident. With the CPM chart and the estimated time for each activity we can proceed in an entirely mechanical manner through addition and subtraction to determine the overall time required for the project, the earliest time each activity in the project can be started and fin-

ished, and the latest time each job within the project can be started and finished without extending the total time of the project. Activities having the minimum (usually zero) difference between the early and late times are critical. These scheduling calculations are valid only if the project is actually built as shown on the CPM chart if the individual jobs are done in the time estimated.

Control conjures up various visions of omnipotence. As used is discussing CPM application, control is a management science term which means no more than comparing what is actually being done with what was planned to be done. Semantically, perhaps, "monitor" would be a better word. As with any control system, CPM enables one to spot difficulties and, in some instances, helps one discover some alternative solutions. It is still, however, up to the management of the project to decide what must be done when unforeseen bottlenecks arise.

III. Aspects of Implementation

A few comments on some common misconceptions regarding CPM in construction are in order, as well as several, perhaps impertinent, remarks on several pertinent questions relating to the implementation of CPM. Let us first consider some current misconceptions.

"A person skilled in the techniques of CPM but having only a superficial knowledge of construction can plan and schedule construction." False! This will only produce a plan of action which will probably result in inaction. An analogy would be to say that because a structural detailer is facile with the graphical symbols used to represent a steel structure, he can do structural engineering.

"An electronic digital computer and a Ph.D. in mathematics is needed." False! To be sure, most, if not all, doctoral candidates equipped with the most advanced data processing equipment can add, subtract and manipulate the simple rules and symbols of CPM. They are "needed" in the same way a sixteen pound sledge hammer is "needed" to drive a 6d nail into a soft pine board. If you wish to present the information on a CPM construction schedule in a series of unrelated one line shots of information sorted out in numerous ways so as to produce reams of useless paper, a computer is indispensable.

"The simplicity of CPM makes it trivial." False! One could

compare this to cost control where money spent divided by units of work done equals actual unit cost which is greater than or less than estimated unit cost. Anyone knowledgeable in construction cost control knows that this simple principle is complex in implementation. Similarly, the uncomplex principles of CPM require much thought in actual application to a construction project.

"By concentrating almost exclusively on critical activities, which are a small percentage of the total, one can successfully complete a construction project through 'management by exception.' " False! On a tightly scheduled construction project, especially in buildings, criticality is an accident of arithmetic. The great majority of activities will have less than two weeks leeway. To presume that portions of the work having but a few days leeway are safe, and will somehow take care of themselves, is a fatal mistake. Anyone experienced in construction knows how quickly a couple of weeks can go by in straightening out some of the problems that arise due to the inherent uncertainties of construction.

There are several points relating to the use or abuse of CPM on which I wish to express opinions developed from experience in planning and scheduling construction throughout the eastern U.S. for numerous contracting and engineering firms.

To what extent is CPM actually used? If you wish to count the work done by quantity surveyors between bids, the doodlings of the job engineer confined to the trailer on a rainy afternoon, the arrow diagram displayed on the wall of the main office but never looked at, the use of CPM is extensive. If however, you wish to count only those cases where CPM is used as the true plan for construction, prepared and implemented by a job management team skilled in obtaining the maximum results this system can yield, CPM has barely gained a foothold.

On the negative side, CPM can be a hindrance to reasonable project management. It can be used to observe as well as clarify. It can be used as a club as well as a tool. It can be backward looking, seeking to place or shift the blame for lack of progress rather than forward looking, seeking to bring the project to a successful conclusion. It can be a sales gimmick rather than an objective prequalification tool on negotiated work.

CPM should be specified only when *both* the specifier and *all* bidders are *both knowledgeable* and experienced with CPM, or an

adequate provision is made to obtain assistance of someone who is. The result of doing otherwise will be the production of considerable paper which is useless to the owner, architect and engineers, and endured by the contractor only to insure processing of his monthly requisitions.

Requiring a CPM schedule with the bid appears, at first blush, to be a fine idea. The construction estimator does a commendable job in taking off and pricing the general construction work, collecting and analyzing subbids, and evaluating contingencies, overhead, profit, etc. in time to produce a firm bid on the specified date. To add the additional task of preparing a CPM schedule is quite impractical. Further, the great bulk of time, effort and expense would be expended on detail planning of jobs the contractor will never get to actually build.

When a consultant is retained to assist in applying CPM he should be regarded as a sort of part-time or day/labor construction manager who is thoroughly knowledgeable about CPM and who can effectively work with construction personnel in the field and office. In setting up a project he should train the project manager, superintendent and engineers involved so that they can use the tool he provides for them and not become a permanent expense to the client. In addition to providing in depth training for key men in a construction company by working with them on a few jobs, he should be able to conduct an interesting briefing session for those in the firm who need to have an overall understanding of the use of CPM without getting into the finer details of the system.

IV. Conclusion

Despite being somewhat oversold and underused or mis-used, CPM will eventually be accepted and knowledgeably applied by competent experienced construction managers based upon its real merit as a project management tool. Based on a solid foundation in planning, scheduling, and control, construction managers will readily be able to expand their techniques into expediting systems, multi-project operations, resource leveling and other advanced applications of CPM.